Introduction to Computer Vision, 2015

Final Exam

- Answer the following 3 questions.
- You may write your answers either in Hebrew or in English.
- Length of exam: 3 hours.

Good luck!

Q1:

1. A camera is imaging a tabletop with objects (see picture below) resulting in image I_1. The camera setting is then changed, producing another image I_2. Consider the following two types of changes in camera settings:

   i. The camera was rotated before taking I_2.

   ii. The camera was both translated and rotated.

   Please answer the following questions for each of the above cases (*i, ii*):

   (a) What is the geometric relation between the images I_1 and I_2? Explain.

   (b) What is the minimum number of corresponding points between the two images required in order to recover this relation?

2. Consider the following three types of changes in camera settings between I_1 and I_2:

   i. The camera is rotating around its optical axis.

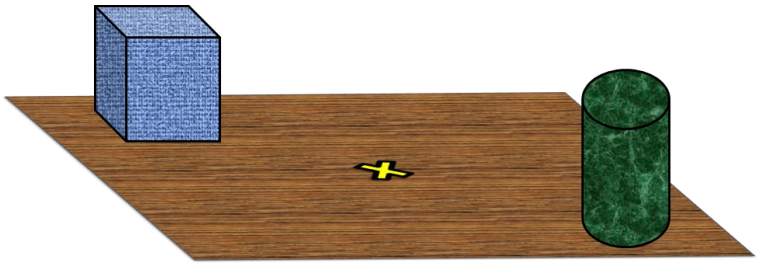
   ii. The camera is zooming toward the point marked by the yellow cross.

   iii. The camera is translating toward the point marked by the yellow cross.

   Image I_2 is wrapped toward image I_1 using a global homography, which brings the brown tabletop into alignment. For each of the above three cases (*i-iii*), answer the following questions:

   (a) Is there any *residual* 2D motion between the two images after alignment? Explain why.

   (b) If so, what does this residual motion field look like? (If you wish, you can draw it schematically. A zero flow vector can be marked by a point.)



Q2:

1. Is it possible to discretely sample a function $f : \Re \longrightarrow \Re$ at uniform finite distances without loosing any information? (i.e., can we sample $f(x)$ discretely, and be able to reconstruct the complete $f(x)$ back from its discrete samples?) Explain when (no need to prove).
2. Can we discretely sample a function $f(x) = \sin(x)$ at uniform finite distances without loosing any information? If so, what is the maximal possible distance?
3. Is the function $g(x) = \sin(x) * \sin(x/2)$ band limited, and if so, what is its maximal frequency? ('$*$' denotes convolution.)
4. $f(x) = \sin(x)$ is sampled by one of the following sampling distances:
   i. $\Delta x = 0.7\pi$
   ii. $\Delta x = 2\pi$
   iii. $\Delta x = 1.5\pi$

   For each the above three cases (*i-iii*) answer the following questions:
   (a) Can $f(x)$ be recovered from its discrete samples?
   (b) If not, what would be the falsely recovered function?

Q3: Explain briefly the following concepts:

1. Is color vision obtained by the eye or by the brain? Explain.
2. What is computed in the first visual area, V1?
3. What is a HoG descriptor of an image patch?